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(6) ATLAS MA-3 SUSTAINER AND BOOSTER VIBRATION TEST PROGRAM

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FOREWORD

This specification was prepared in response to Technical Directive BSRPW-1-3 dated 1 March 1963, Contract AF04(694)-328.

ABSTRACT

This specification includes the design criteria and test program to be conducted by Rocketdyne for the vibration test of two Atlas MA-3 rocket engines. The primary purpose of these tests is to determine whether any marginal design conditions exist on fluid lines and their supports.

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ILLUSTRATIONS

TABLES

ATLAS ENGINE VIBRATION TESTS DETAILED TEST PROGRAM

1. SCOPE

The scope of the Atlas engine vibration test is to determine if any severe resonant conditions can exist that will cause fluid line leakage when subjected to known vibration environments.

1.1 PURPOSE

Vibration tests will be made of a sustainer engine (MA-3 LR105NA5) and a booster engine (MA-3 LR89NA5) to determine if any detrimental resonant conditions can exist that will cause fluid line leakage. Many resonant conditions of fluid lines, bracket-mounted components and structural members are expected to be found. However, the types of resonances that can cause concern are those where (1) lines or components undergo large deformations and result in fatigue-type failures of structural members, (2) lines that show considerable damping in the B-nut area indicating rubbing on the sealing surfaces (3) components having large differential movements, thus requiring flexibility in the connecting fluid lines, and (4) resonances that occur close to known major frequencies generated by the engine itself. If any potential failure points are detected during these tests, means of eliminating them will be developed and tested immediately.

2. SUSTAINER ENGINE

2.1 ENGINE CONFIGURATION

2.1.1 The sustainer engine configuration will include all current effective modification kits, i.e. particularly those kits concerning the addition of clamps, rerouting of lines, and additional supports for lines or components.

2.1.2 The engine will be reworked at the Rocketdyne Canoga Park facility for item 2.1.1, above. Specific lines listed in Table A-2, Appendix A , will be reworked so that they may be pressurized to simulated working pressures (blank orifices or plugs will be used). The fluid media and connect points are given in Table A-1, Appendix A .

2.1.3 Any external electrical harnesses or lines (instrumentation) will be secured so as to not interfere with the test program.

2.2 TEST SETUP

2.2.1 The sustainer engine shall be maintained in a horizontal position and suspended by a soft-mounting system (using shock cord) such that the natural frequency of the total system (suspension and engine) is less than 3 cps (approximately 1-inch static deflection).

2.2.2 Orientation

The suspension system shall be such that the engine can be vibrated in the lateral or longitudinal direction, while the engine is in a horizontal attitude.

2.2.3 Attach points for the shaker shall be provided at the pump strut tie point near the throat area for lateral excitation, and at gimbal point for longitudinal excitation (Fig. 1). The fixture will be designed such that the forcing function is applied through an axis which passes through the center of gravity (cg) of the engine-fixture assembly.

2.2.4 Critical lines (those lines specified by design that are critical to engine operation) will be pressurized to simulated working pressures. Table A-2, Appendix A , shows pressures and fluid media.

2.3 SPECIAL EQUIPMENT

2.3.1 Instrumentation

2.3.1.1 Accelerometers. A minimum of ten accelerometers will be required. These will be mounted on small, contoured aluminum blocks to fit 1/4-, 3/8-, 1/2-, 3/4- and 1-inch lines using cement or double-backed, pressure-sensitive tape. Outputs of the accelerometers will be recorded on an oscillograph and/or oscilloscopes. Location of accelerometers will be at the shaker input, on components and on support points of lines (Table A-2, Appendix A).

2.3.1.2 A strobe-light system will be used to define vibration modes of line spans. Displacement wedges will be used to define large amplitudes of lines.

2.3.1.3 Strain gages will be installed on critical lines as indicated in Table A-2 , Appendix A . Strain gages will be recorded on the recording oscillograph to determine dynamic stress levels. Strain gages will be located near B nuts or near line support points.

2.3.2 Pressure gages will be required to monitor working pressures of critical lines.

2.4 TEST PROCEDURE

2.4.1 Prior to the start of each test run, working pressures of each line shall be applied and recorded.

2.4.2 Accelerometer calibration shall be recorded and verified when deemed necessary.

2.4.3 Test 1, Resonance and Amplification Determination, Lateral Direction

2.4.3.1 The vibration excitation shall be applied in the lateral direction in an input of 2-g peak, and the sensitive resonances and amplification factors and components shall be recorded. A sweep cycle from 500 to 20 cps (in a 5-minute sweep) at 2-g peak shall be recorded for the accelerometer locations in Table A-2, Appendix A).

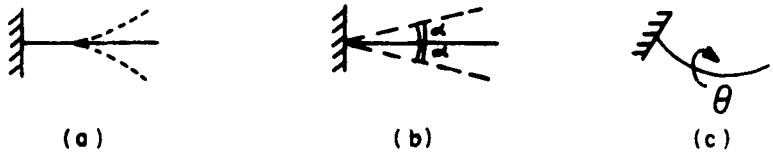
2.4.3.2 Repeat 2.4.3.1 for a 5-g peak input.

2.4.3.3 Repeat 2.4.3.1 for a 10-g peak input.

2.4.3.4 Observations of line resonance conditions

2.4.3.4.1 Visual. The following visual observations should be made to detect the type of motion at the line tie points (B nut or clamp):

1. Line bending in translation with no movement at B nut, little or no damping
2. Line rotating through small angles at a B-nut indication rubbing on the flared surface; damping and wear occurring
3. Line turning about its longitudinal axis at a B nut, torsional motion on the flared surface



(a) (b) (c)

4. Large motions of lines at low-input levels per Paragraph 2.3.1.2

2.4.3.4.2 Recorded Data. The recorded data (strain and acceleration) will be analyzed to determine resonant frequencies, amplification factors, damping and nonlinear response to increasing input levels.

2.4.3.5 Resonant frequencies of particular interest are: 100, 150, 200, 300 and 400 cps ±10 cps. These frequencies are normally generated by the engine. Frequencies below 100 cps can be generated by the missile airframe and are also of interest, particularly where low-level inputs (2-g peak) are concerned.

2.4.3.6 During the above sweep tests, all failures and leakages should be noted. In the case of leakage at B nuts, torque values should be recorded noting differences between pre-test torque and torque when leakage occurred. Failures shall be considered as any crack developing in a component bracket or line support; loosening of a line clamp that forms part of a line support; rotation of a B nut, screw or bolt; cracks in tubes causing leakage; separation of 100 percent or more of the braid on a flexible hose. Total test time and test level to failure shall be recorded for each failure.

2.4.4 Test 2, Damping Determination

2.4.4.1 For those lines in Test 1 that exhibit high amplification factors, the effective damping shall be determined by decay records.

2.4.4.2 Evaluation of additional damping methods will be conducted on those lines that require a reduction in amplification to prevent leakage or failure. This may also be accompanied by the addition of supports to raise the natural frequency and thereby reducing the maximum deflection and associated repeated stress level.

2.4.4.3 Decay records will be made by instanteously removing the excitation force, or by a step input force.

2.4.5 Test 3

This will be a rerun of Tests 1 and 2 to evaluate fixes.

2.4.6 Test 4 Resonance and Amplification Determination in the Longitudinal Direction

2.4.6.1 Repeat Paragraphs 2.4.3 through 2.4.5 for the longitudinal direction.

3. BOOSTER ENGINE

3.1 ENGINE CONFIGURATION

3.1.1 The booster engine configuration will include all current effective modification kits, i.e. particularly those kits concerning the addition of clamps, rerouting of lines, and additional supports for lines or components.

3.1.2 The booster engine will be reworked at the Rocketdyne Canoga Park facility for items in Paragraph 3.1.1. Specific lines listed in Table B-2, Appendix B, will be reworked such that they may be pressurized to normal working pressures (blank orifices or plugs will be used). The fluid media is given in Table B-2, Appendix B. Pressurization connect points are given in Table B-1, Appendix B.

3.1.3 Any external electrical harnesses or line (instrumentation) will be secured so as to not interfere with the test program.

3.2 TEST SETUP

3.2.1 The booster engine shall be maintained in a horizontal position and suspended by a soft-mounting system (using elastic shock cord) such that the natural frequency of the total system (suspension and engine) is less than 3 cps (approximately 1-inch static deflection).

3.2.2 Orientation.

The suspension system shall be such that the engine can be vibrated in the lateral or longitudinal direction, while the engine is in a horizontal attitude.

3.2.3 Attach points for the shaker shall be provided at a point on the pump-to-chamber fixture for the lateral excitation and at the gimbal point for the longitudinal excitation. The fixture will be designed to provide a common rigid tie point for the pump and gimbal block, such that the forcing function is applied through an axis which passes through the center of gravity of the engine-fixture assembly.

3.2.4 Critical lines (those lines specified by design that are critical to engine operation) will be pressurized to simulate working pressures. Table B-2, Appendix B, shows the pressures and fluid media.

3.3 SPECIAL EQUIPMENT

The special equipment required is that which is listed in Paragraph 2.3. Table B-2, Appendix B, lists lines which require special instrumentation.

3.4 TEST PROCEDURE

The test procedure outlined in Paragraph 2.4 for the sustainer engine will be applied in a similar sequence to the booster engine.

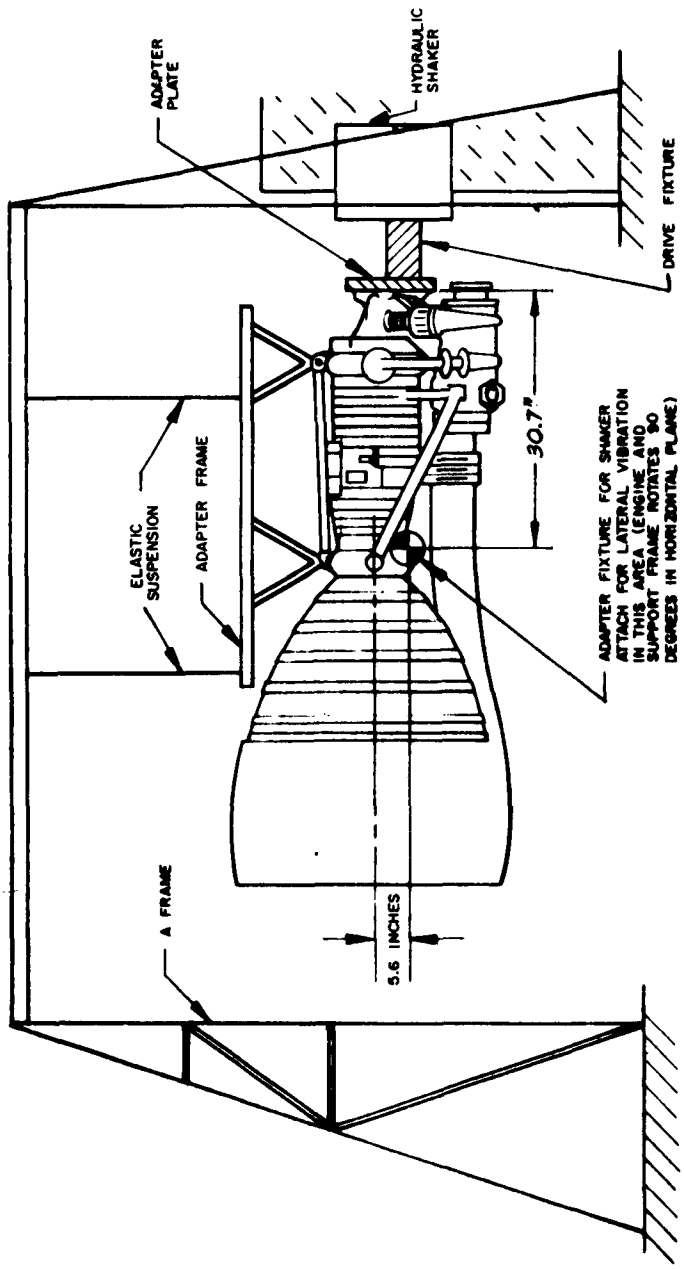


Figure 1. Test Setup for Vibration of Sustainer Engine

APPENDIX A

MA-3 SUSTAINER ENGINE (LR 105 NA-5) S/N 222827

Presented in Appendix A are the Mod configuration, the Atlas MA-3 engine vibration program schedule (Fig. A-1), sustainer system connect points (Table A-1 , and Fig. A-2 and A-3), sustainer critical engine lines (Table A-2), sustainer leak check and pressurizing procedure, MA-3 sustainer engine schematic (Fig. A-4), and the sustainer engine modifications (Table A-3).

MOD CONFIGURATION

Below is Mod configuration of the test engine:
2x45x710x1214x16x1920x2425x27x32x34x37x39x4850x53x5658x60

Fixture Attachment Data

1. Oxidizer elbow
   Ref: Drawing 400598
2. Number 1 and 2 actuator connect points
   Ref: Drawing 100125 sheet 1 of 2, zone 5 and 6
3. Attach point for shipping purposes
   Ref: Drawing 100125 sheet 1 of 2, zone 13 and 18
4. Attachment points for handling purposes
   Ref: Drawing 100125 sheet 1 of 2, zone 7
   Attachment No. 1, zone 14, Attachment No. 2 and 3

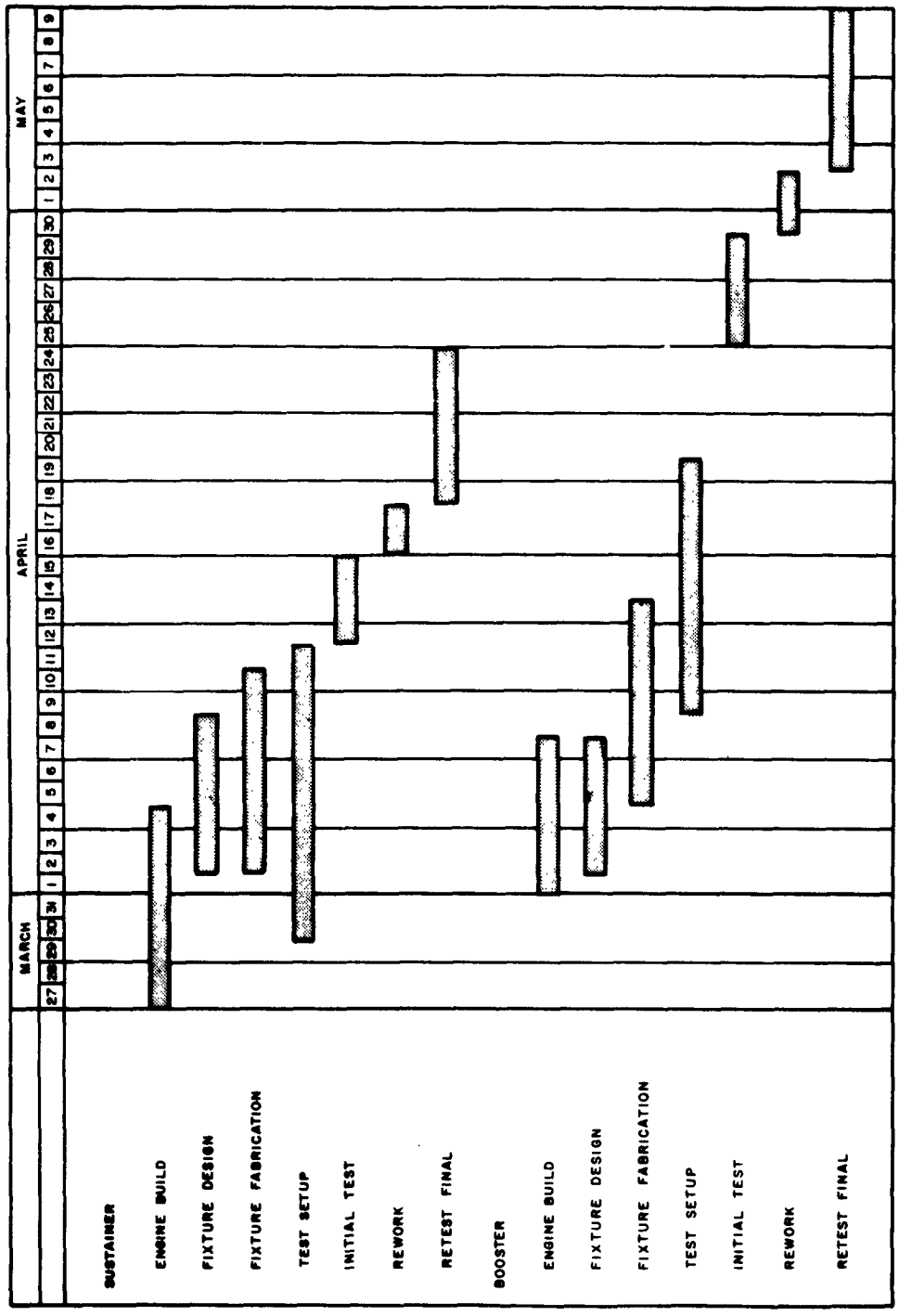


Figure A-1. Rocketdyne Atlas MA-3 Engine Vibration Program Schedule

TABLE A-1

SUSTAINER SYSTEM CONNECT POINTS

Connect Points	Pressure, psig	Media	Systems Pressurized
Fuel System			
1. Fuel Elbow	750	Water	Main feed, bootstrap, lube actuation, mixture ratio controller, fuel elbow to igniter port
2. Fuel Control Line at Thrust Chamber	750	Water	Fuel control
3. Fuel Coolant, at Turbine	750	Water	Fuel coolant
Oxidizer System			
4. Connector Tee, Customer Connect	750	Water	Oxidizer bootstrap and regulator
5. Oxidizer Sensing at Hydraulic Package	750	Water	Oxidizer sensing line
Hydraulic System			
6. Hydraulic Package, Customer Connect Supply	750	Hydraulic	Engine hydraulic system
7. Hydraulic Package, Customer Connect Return	750	Hydraulic	Engine hydraulic system
7a. Hydraulic Package Drain Port	- -	Hydraulic	- -

TABLE A-1

(Continued)

Connect Points	Pressure, psig	Media	Systems Pressurized
	Lube System		
8. Lube Oil Preservative Fitting, 1/4-inch Capped Port	200	Water	Turbopump lube system
9. Customer Connect Lube Tank	40	Gaseous Nitrogen	Lube tank assembly

Note: 1. For system location of connect points see Fig. A-2 through A-4 .
2. All connect points are AN standard 1/4-inch, except those specified .

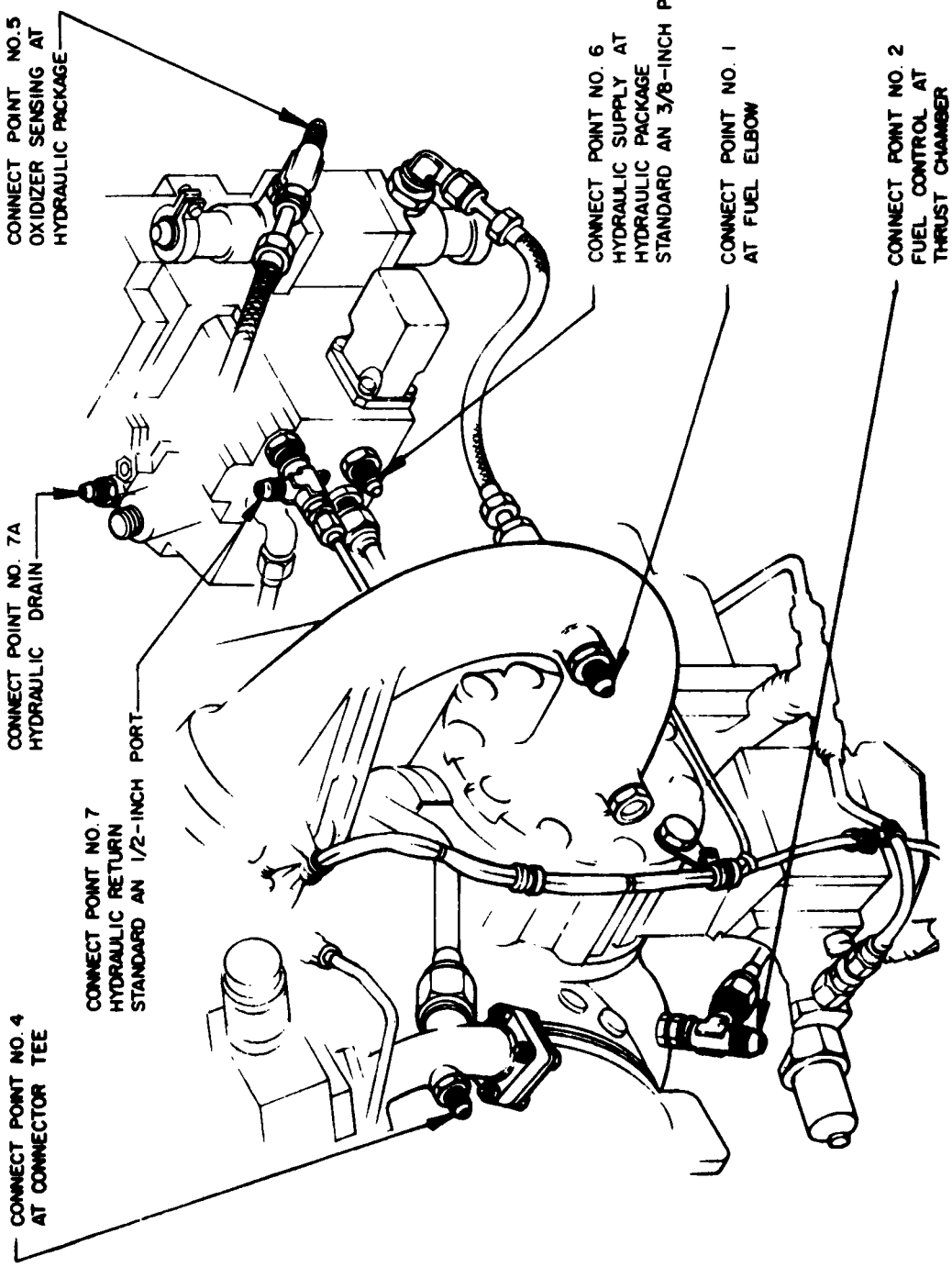


Figure A-2. Sustainer System Connect Points, No. 1, 2, 4, 5, 6, 7 and 7a

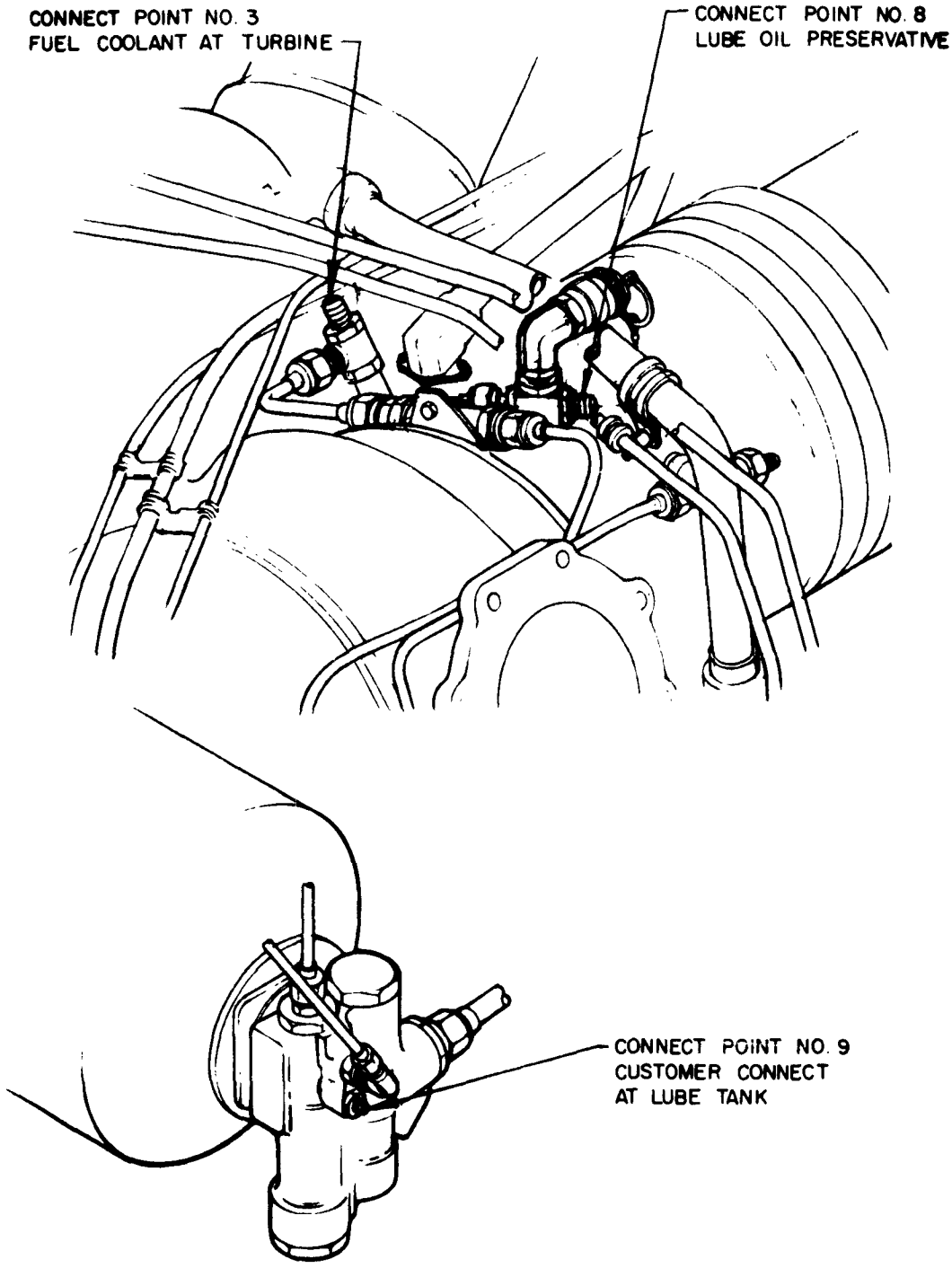


Figure A-3. Sustainer System Connect Points No. 3, 8 and 9

TABLE A-2

SUSTAINER CRITICAL ENGINE LINES

Line	Part Number	Normal Media	Test Medi
Fuel Bootstrap	301716	Fuel	Water
Oxidizer Bootstrap	301734	Oxidizer	Water
Ignition Fuel to Hypergol	302833	Fuel	Water
Fuel Elbow to Igniter Valve	302834	Fuel	Water
Oxidizer Regulator, Sensing Line	306849	Oxidizer	Water
Hypergol to F Valve	400953	Fuel	Water
F Valve to Thrust Chamber	402247	Fuel	Water
Fuel Bootstrap	403728	Fuel	Water
No. 4 Bearing to No. 3 Bearing	451865	Lube	Water
Volute to Fuel Relief Valve	455110	Fuel	Water
Fuel Relief Valve to Turbine	455111	Fuel	Water
Lube Supply	552781	Lube	Water
Lube Valve Actuation	555242	Fuel	Water
Lube Tank Pressurization	551123	Pneumatic	Gaseous Nitrogen
Head Suppression Open	600256	Hydraulic	Hydraulic
Head Suppression Close	600257	Hydraulic	Hydraulic
Propellant Utilization Open	600258	Hydraulic	Hydraulic
Propellant Utilization Close	600259	Hydraulic	Hydraulic
Oxidizer Sensing	600262	Oxidizer	Water
Propellant Utilization Stop	600269	Hydraulic	Hydraulic
Fuel Sensing	600755	Fuel	Water
Gas Generator Open	600765	Hydraulic	Hydraulic
Gas Generator Close	600766	Hydraulic	Hydraulic
Oil Pump to Gear Jet	9512-48385-13	Lube	Water
Oil Pump to No. 1 Bearing	9512-48385-15	Lube	Water
Gear Case Drain	301766	Lube	None
Fuel Sensing	NA5-26356	Fuel	Water
Oxidizer Sensing	NA5-26356	Oxidizer	Water
Fuel Inlet Sensing	NA5-26421	Fuel	Water

*A - Accelerometer
S - Strain Gage

2

TABLE A-2

ISTAINER CRITICAL ENGINE LINES

Normal Media	Test Media	Pressure, psig	Tube OD and Material	Instrumentation*	
				A	S
Fuel	Water	750	1.0-inch Aluminum	x	x
Oxidizer	Water	750	3/4-inch Aluminum	x	x
Fuel	Water	750	3/8-inch CRES	-	x
Fuel	Water	750	1/2-inch CRES	x	-
Oxidizer	Water	750	1/4-inch Aluminum	-	-
Fuel	Water	750	3/8-inch CRES	-	-
Fuel	Water	750	3/8-inch CRES	-	x
Fuel	Water	750	1.0-inch Aluminum	-	x
Lube	Water	200	1/4-inch Aluminum	-	-
Fuel	Water	750	1/4-inch Aluminum	-	-
Fuel	Water	750	1/4-inch Aluminum	-	-
Lube	Water	40	1/2-inch CRES	x	x
Fuel	Water	750	1/4-inch CRES	-	x
Pneumatic	Gaseous Nitrogen	40	1/4-inch CRES	-	-
Hydraulic	Hydraulic	750	3/8-inch CRES	-	x
Hydraulic	Hydraulic	750	3/8-inch CRES	-	-
Hydraulic	Hydraulic	750	3/8-inch CRES	-	x
Hydraulic	Hydraulic	750	3/8-inch CRES	-	-
Oxidizer	Water	750	1/4-inch CRES	-	x
Hydraulic	Hydraulic	750	3/8-inch CRES	-	-
Fuel	Water	750	3/8-inch CRES	-	x
Hydraulic	Hydraulic	750	3/8-inch CRES	-	x
Hydraulic	Hydraulic	750	3/8-inch CRES	-	-
Lube	Water	200	1/4-inch CRES	-	-
Lube	Water	200	1/4-inch CRES	-	-
Lube	None	None	1.0-inch CRES	x	-
Fuel	Water	750	1/4-inch CRES	-	-
Oxidizer	Water	750	1/4-inch CRES	-	-
Fuel	Water	750	1/4-inch CRES	-	-

SUSTAINER LEAK CHECK AND PRESSURIZING PROCEDURE

LEAK CHECK BY SYSTEMS

1. LUBE SYSTEM

1.1 Connect supply line to connect point No. 8 (Table A-1 and Fig. A-3).

1.1.1 Supply 10-psig water pressure to system.

1.1.2 Crack the B nuts at the following locations to allow for venting of the system.

1.1.2.1 Lube line 9512-48385-13
1.1.2.2 Lube line 9512-48385-15

NOTE: Each B nut should be loosened and retorqued separately before proceeding to the next B nut.

1.1.3 Build up pressure to working value given in Table A-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting, and repeat step above.

1.1.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

1.2 Connect a pneumatic supply line to connect point No. 9 (Table A-1 and Fig. A-3).

1.2.1 Disconnect the lube valve actuation line from the lube valve and connect a pneumatic line to the actuation port.

1.2.2 Connect a water supply line to the lube tank through the aft quick disconnect assembly.

1.2.3 Disconnect drain line from valve and install flexible drain line.

1.2.4 Fill tank with water until steady stream of water is noted coming from drain line.

1.2.5 Remove water supply line.

1.2.6 Pressurize the lube valve actuation port to 155 psig. This will close the drain port and open the lube oil supply port and pneumatic supply port.

1.2.7 Pressurize the pneumatic supply point (connect point No. 9) to 40 psig.

1.2.8 Crack the lube oil supply line B nut at the pump inlet. Retorque after venting is complete. Leak check remainder of lube system.

1.2.9 Depressurize the lube valve actuation port.

1.2.10 Depressurize the pneumatic supply line.

1.2.11 Remove the pneumatic line from the lube valve actuation port and reconnect the lube valve actuation line.

NOTE: Do not drain the water from the lube tank assembly.

GENERAL NOTE: All care should be taken to prevent the systems, once primed and leak checked, from being drained, and thus allowing air entrapment in the lines.

2. OXIDIZER SYSTEM

2.1 Connect supply line to connect point No. 4 (Table A-1 and Fig. A-2).

2.1.1 Supply 10-psig water pressure to system.

2.1.2 Crack the B nuts at the following locations to allow for venting of the system:

2.1.2.1 306849 oxidizer regulator sensing line at adapter

2.1.2.2 Oxidizer bootstrap at gas generator assembly

NOTE: Each B nut should be loosened and retorqued separately before proceeding to the next B nut.

2.1.3 Build up pressure to working value given in Table A-1. Observe system for leakage.

NOTE If leakage should occur, depressurize system, retorque fitting, and repeat step above.

2.1.4 Depressurize system; pressure supply line may be disconnected

2.2 Connect supply line to connect point No. 5 (Table A-1 and Fig. A-2).

2.2.1 Supply 10-psig water pressure to system.

2.2.2 Crack the B nut at the following location to allow for venting of the system

2.2.2.1 Oxidizer sensing at dome assembly

NOTE Retorque after venting is complete

2.2.3 Build up pressure to working value given in Table A-1. Observe system for leakage.

NOTE If leakage should occur, depressurize system, retorque fitting, and repeat step above.

2.2.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

3. HYDRAULIC SYSTEM

3.1 Connect hydraulic cart supply return and drain lines to connect points No. 6, 7, and 7a (Table A-1, and Fig. A-2 and A-3).

3.1.1 Slowly increase hydraulic pressure to working value (Table A-1). Observe system for leaks.

NOTE: If leakage should occur, depressuize system, retorque fitting and repeat above step.

3.1.2 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

4. FUEL SYSTEM

4.1 Connect supply line to connect point No. 1 (Table A-1 and Fig. A-2).

4.1.1 Supply 10-psig water pressure to system

4.1.2 Crack the B nuts in following locations to allow for venting of the system:

4.1.2.1 Lube valve actuation port
4.1.2.2 Gas generator crack and check valve
4.1.2.3 Mixture ratio controller
4.1.2.4 Igniter fuel port

NOTE. Each B nut should be loosened and retorqued separately before proceeding to the next B nut.

4.1.3 Buildup pressure to working value given in Table A-1. Observe system for leakage.

NOTE. If leakage should occur, depressurize system retorque fitting, and repeat step above.

4.1.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

4.2 Connect supply line to connect point No. 2 (TableA-1 and Fig. A-2).

4.2.1 Supply 10-psig water pressure to system.

4.2.2 Crack the B nut at the following location to allow for venting of the system:

4.2.2 1 Control por hydraulic package

NOTE. Retorque after venting is complete.

4.2.3 Buildup pressure to working value given in Table A-2. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting and repeat step above.

4.2.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

4.3 Connect supply line to connect point No. 3 (Table A-1 and Fig. A-3.

4.3.1 Supply 10-psig water pressure to system.

4.3.2 Crack the B nut at the following location to allow for venting of the system:

4.3.2.1 Fuel coolant line at fuel volute.

NOTE: Retorque after venting is complete.

4.3.3 Build up pressure to working value given in Table A-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting and repeat step above.

4.3.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

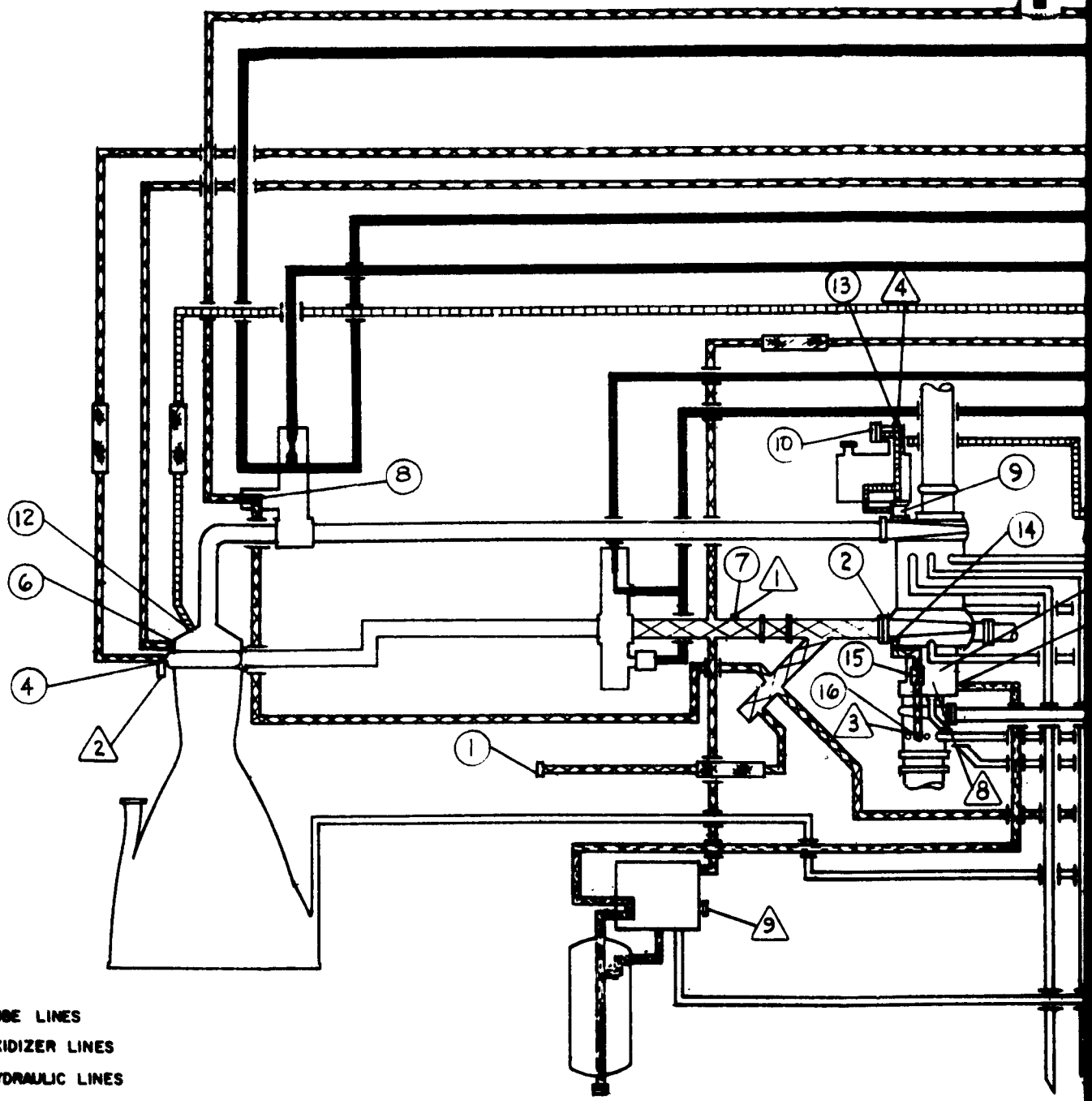
PRESSURIZING PROCEDURE

1.1 Connect all supply lines to the connect points shown in Table A-1 and Fig. A-2 and A-3.

1.2 Slowly build up pressure to those in Table A-1, and in the sequence shown below:

2.2.1 Hydraulic system
2.2.2 Fuel system
2.2.3 Oxidizer system
2.2.4 Lube system

NOTE: All pressures should be monitored. At no time should a B nut be retorqued while pressure is up.



CODE:

- LUBE LINES
- OXIDIZER LINES
- HYDRAULIC LINES
- FUEL LINES
- UNPRESSURIZED LINES
- ○ ENGINE MODIFICATION REFERENCE TABLE A-3
- △ CONNECT POINT REFERENCE TABLE A-1

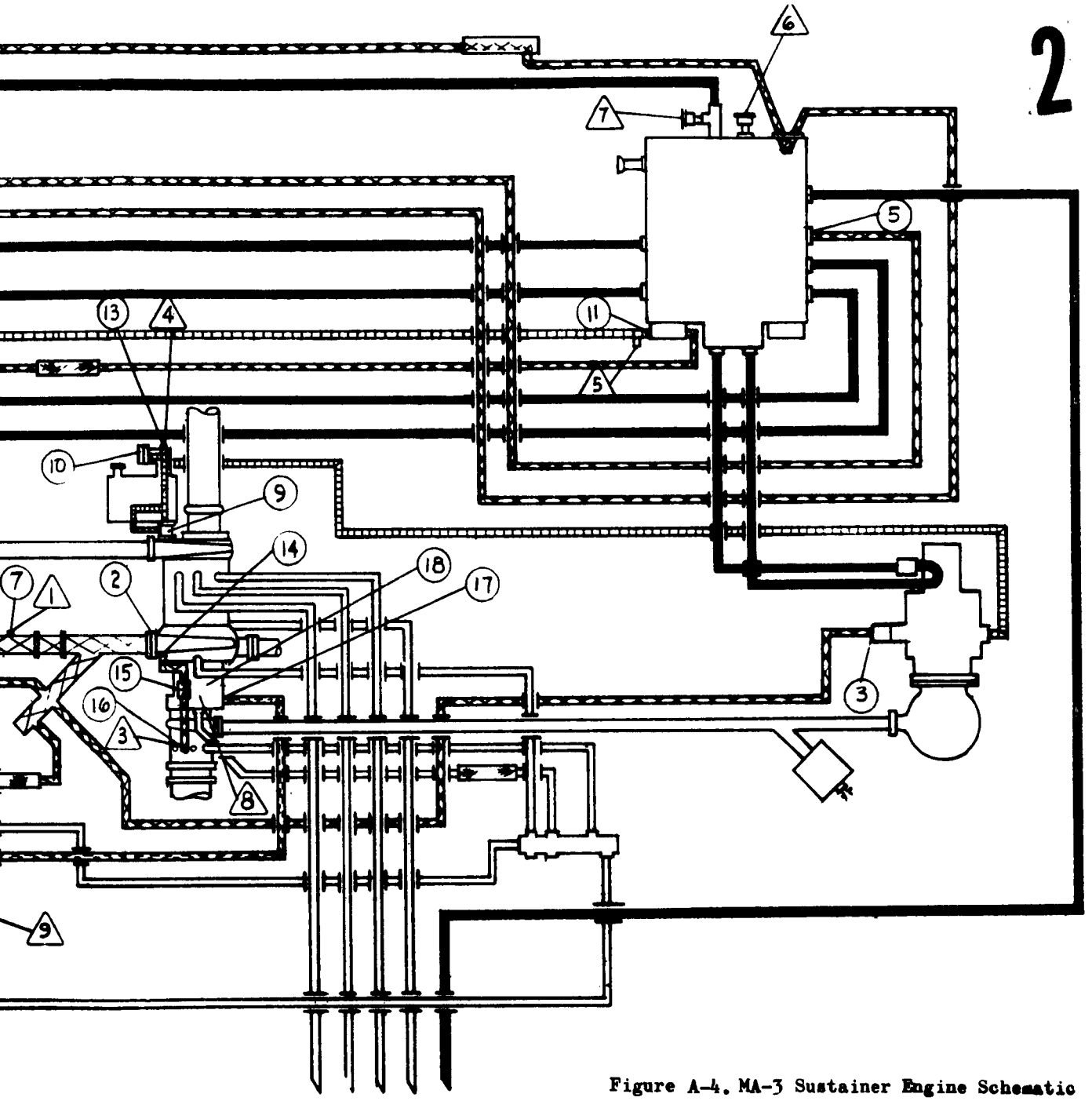


Figure A-4. MA-3 Sustainer Engine Schematic

TABLE A-3

SUSTAINER ENGINE MODIFICATIONS

Item	Name	System	Installation	Modification and Purpose
1	Plate	Fuel	Vernier engine customer connect	Plate added, contain system pressure
2	Plate	Fuel	Fuel pump discharge	Plate added, contain system pressure and prevent over-pressurization of turbopump
3	Fitting	Fuel	Gas generator fuel crack and check valve	Plugged elbow, contain system pressures
4	Fitting	Fuel	Fuel control at thrust chamber manifold	Bulkhead tee with one end of run plugged added, supply pressure to fuel control line
5	Fitting	Fuel	Fuel control at hydraulic package	Bulkhead elbow with one end plugged added, contain system pressure
6	Fitting	Fuel	Thrust chamber igniter port	Fitting added, contain pressure in igniter fuel system
7	Fitting	Fuel	Fuel elbow	Union added, supply pressure to main fuel system
8	Igniter valve	Fuel	Head suppression valve	Reworked valve, allow flow-thru condition in normally closed valve position
9	Plate	Oxidizer	Oxidizer pump, regulator connect	Plate added, contain system pressure and prevent over pressurization of turbopump
10	Plate	Oxidizer	Vernier engine customer connect	Plate added, contain system pressure

TABLE A-3
(Continued)

Item	Name	System	Installation	Modification and Purpose
11	Fitting	Oxidizer	Oxidizer sensing at hydraulic package	Tee added, pressurize oxidizer sensing line
12	Fitting	Oxidizer	Oxidizer sensing at dome	Union added, one end plugged; contain pressure in sense line
13	Fitting	Oxidizer	Connector tee	Union added, supply pressure to oxidizer bootstrap line and regulator
14	Fitting	Fuel	Fuel volute, fuel coolant	Fitting plugged, contain pressure in coolant line
15	Relief valve	Fuel	Turbopump	Rework valve poppet, allow flow in two directions
16	Fitting	Fuel	Turbine, fuel coolant	Turbine fitting plugged, supply pressure to coolant line
17	Fitting	Lube	Lube pump inlet	Elbow plugged, contain pressure in lube tank assembly
18	Jet assemblies	Lube	Turbopump	All lube oil jets welded closed, maintain system pressure

APPENDIX B

MA-3 BOOSTER ENGINE (LR 89 NA-5) S/N 112703

Presented in Appendix B are the Mod configuration, the Atlas MA-3 engine vibration program schedule (Fig. B-1), booster system connect points (Table B-1 , and Fig. B-2 through B-6), booster critical engine lines (Table B-2), booster leak check and pressurizing procedure, MA-3 booster engine schematic (Fig. B-7), and the booster engine modification (Table B-3).

MOD CONFIGURATION

Below is the Mod configuration of the test engine:
3x69x11x13x1619x23x27x29x31x33x35x3738x44x4749

Fixture Attachment Data

1. Mount, exhaust duct to missile
   Ref: Drawing 100654 zone 23
2. Fittings, ground handling
   Ref: Drawing 100654 view AC.AC zone 21, view AB-AB zone 20 and zone 8
3. Mount, turbopump to missile
   Ref: Drawing 100654 zone 8, view AH-AH zone 19, detail K zone 18
4. Fitting, right hand ground handling
   Ref: Drawing 100654 zone 14, view AA-AA zone 15
5. Fitting, ground handling
   Ref: Drawing 100654 zone 13
6. Mount, thrust chamber to missile
   Ref: Drawing 100654 zone 8
7. Mount, gimbal bearing support to missile
   Ref: Drawing 100654 zone 8
8. Fitting, left hand ground handling
   Ref: Drawing 100654

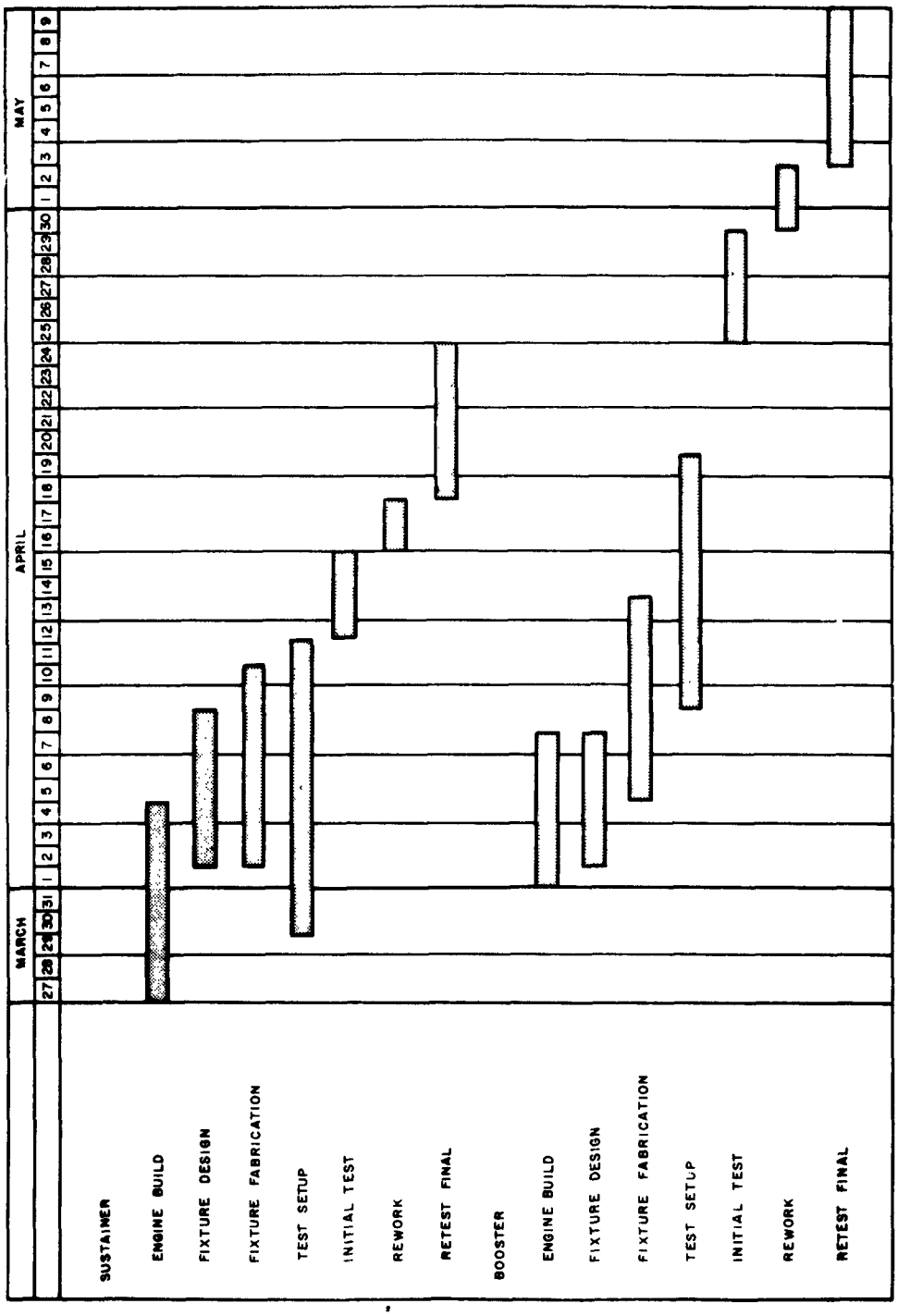


Figure B-1. Rocketdyne Atlas MA-3 Engine Vibration Program Schedule

TABLE B-1

BOOSTER SYSTEM CONNECT POINTS

Connect Points	Pressure, psig	Media	Systems Pressurized
	Fuel System		
1. Hypergol Purge	750	Water	Fuel duct, control manifold, igniter fuel system
2. Fuel Bootstrap at Thrust Chamber Manifold	750	Water	Fuel bootstrap line
3. Fuel Volute Bleed Valve at Volute	750	Water	Fuel volute bleed system
3a. Directional Control Package, Drain	- -	Water	- -
	Oxidizer System		
4. Oxidizer Chilldown Boss	750	Water	Oxidizer duct
5. Oxidizer Bootstrap at Oxidizer Elbow	750	Water	Oxidizer bootstrap line
	Lube System		
6. Turbopump Preservative Oil Disconnect	750	Water	Turbopump lube oil system
7. Customer Connect Helium	40	Gaseous Nitrogen	Lube tank assembly

TABLE B-1

(Continued)

Connect Points	Pressure, psig	Media	Systems Pressurized
	Pneumatic System		
8. Customer Connect Bearing Seal Purge	600	Gaseous Nitrogen	Oxidizer cavity purge line
	Electrical System		
9. Hydraulic Package, Electrical Connect	- -	- -	- -

Note: 1. For system location of connect points see Fig. B-2 through B-7.
2. All connect points are AN standard 1/4 inch, except those specified.

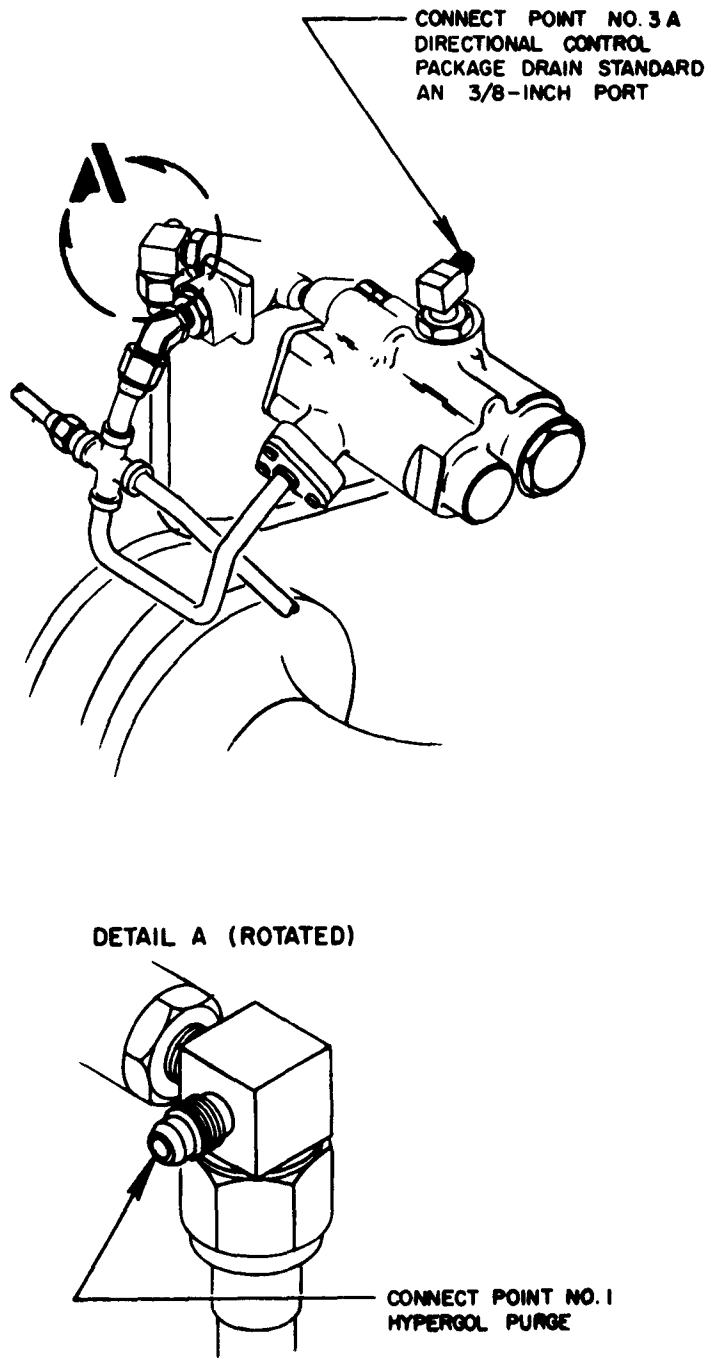


Figure B-2. Booster System Connect Points No. 1 and 3a

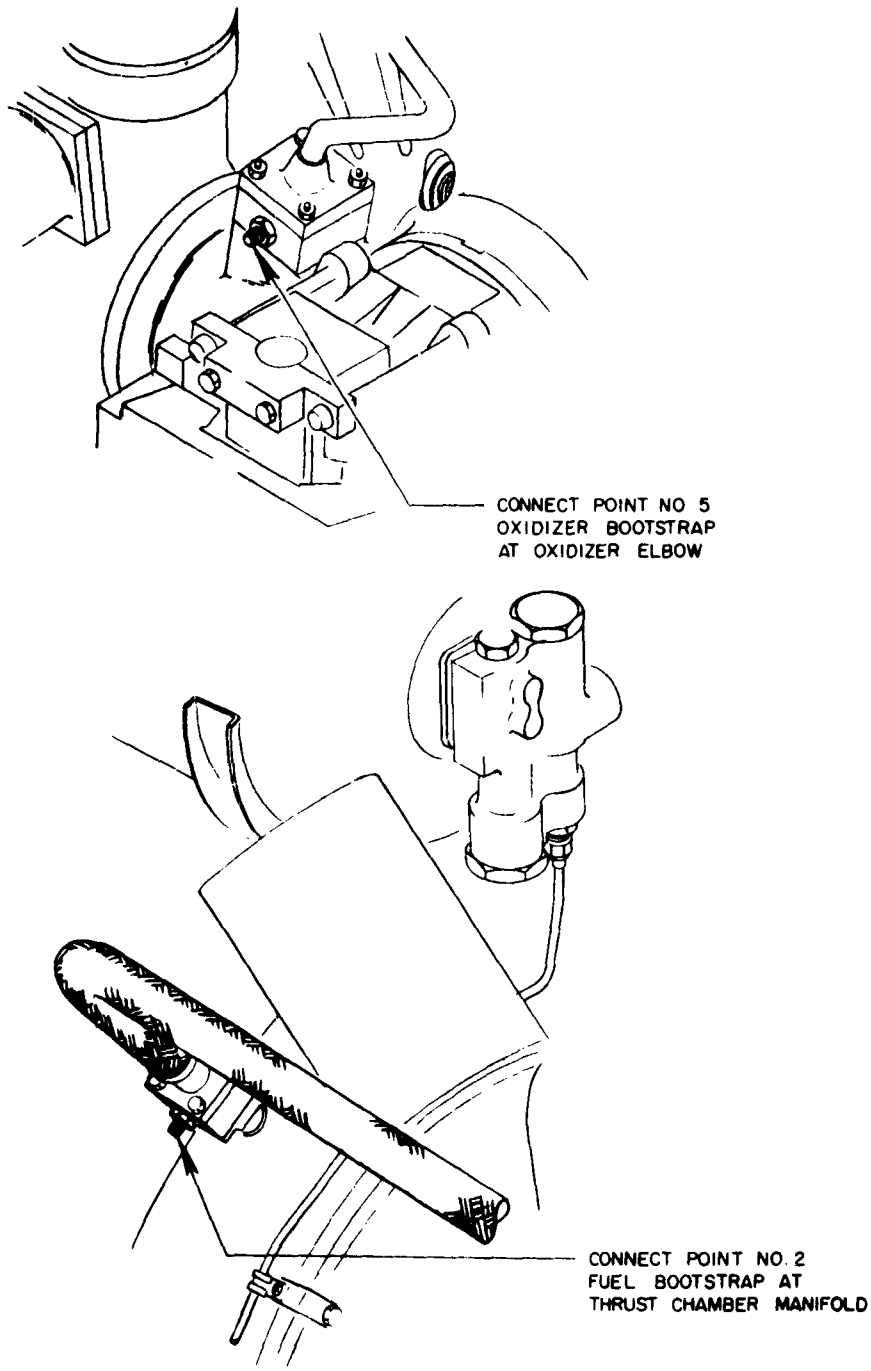


Figure B-3. Booster System Connect Points No. 2 and 5

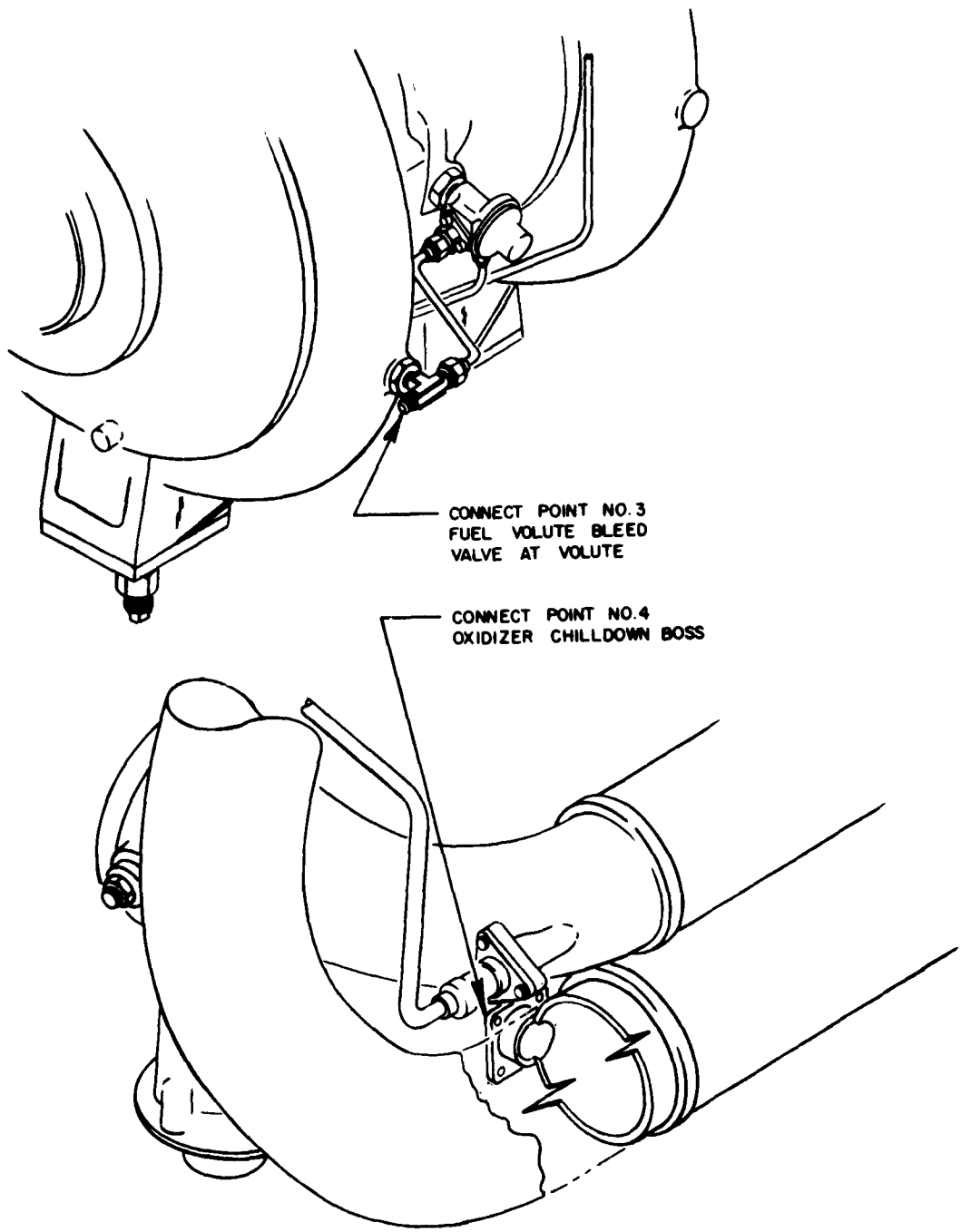


Figure B-4. Booster System Connect Points No. 3 and 4

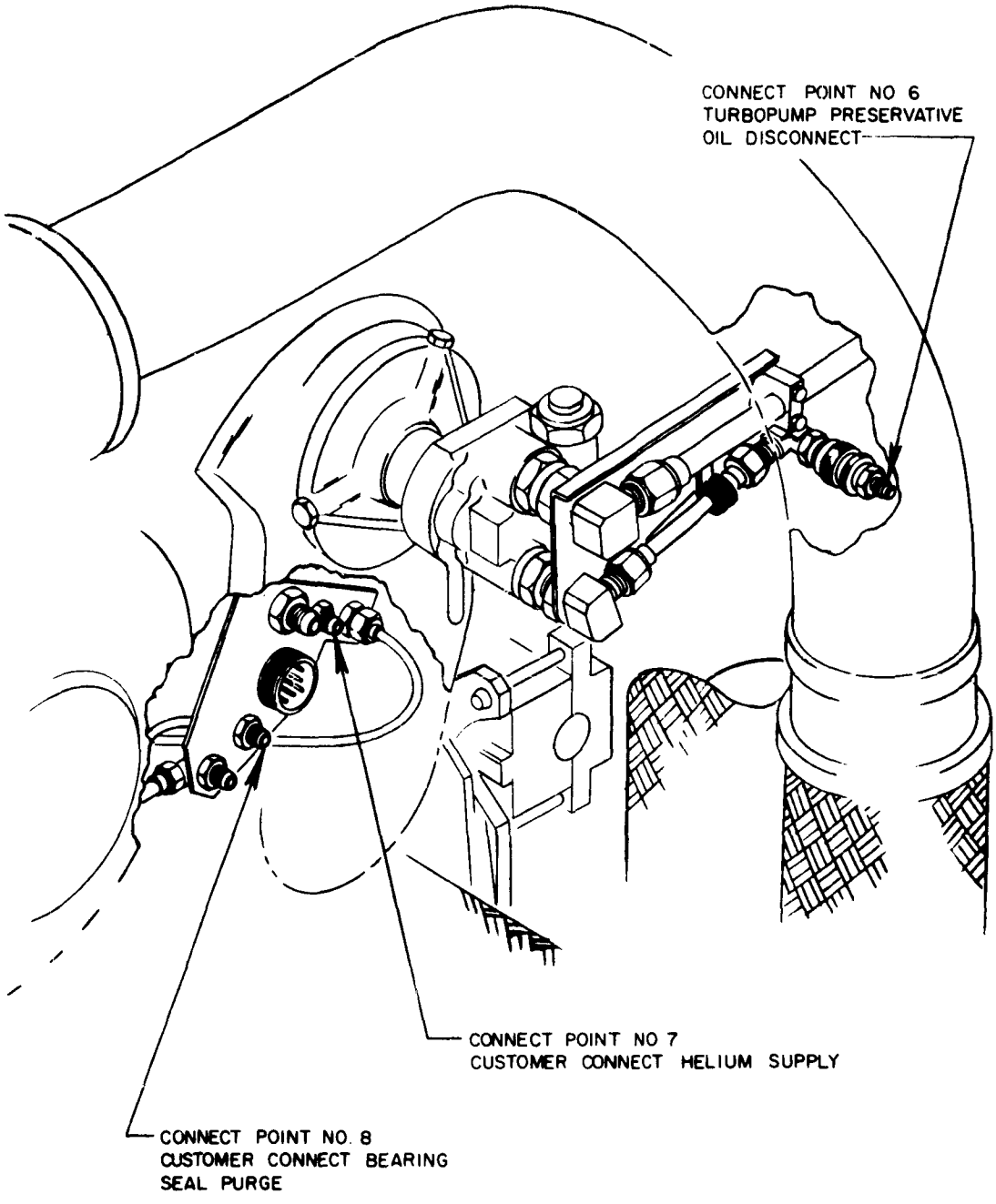


Figure B-5. Booster System Connect Points No. 6, 7 and 8

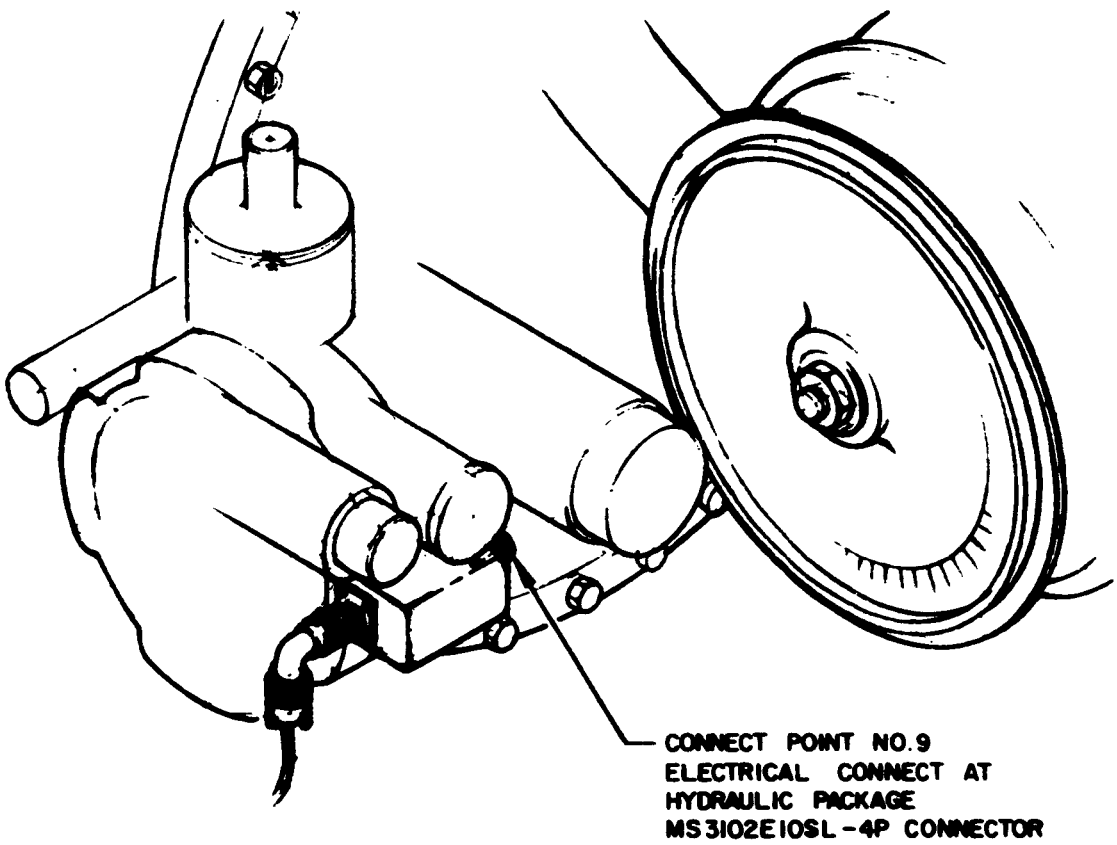


Figure B-6. Booster System Connect Point No. 9

TABLE B-2

BOOSTER CRITICAL ENGINE LINES

Line	Part No.	Normal Media	Test Media	Pressur psig.
Oxidizer Duct	403276	Oxidizer	Water	750
Fuel Duct	401512	Fuel	Water	750
Manifold Assembly	304610	Fuel	Water	750
Hypergol to Thrust Chamber	304607	Fuel	Water	750
Hypergol to Main Fuel Valve	306419	Fuel	Water	750
Igniter Valve to Hypergol	304609	Fuel	Water	750
Oxidizer Bootstrap	NA5-26598	Oxidizer	Water	750
Fuel Bootstrap	NA5-26768	Fuel	Water	750
Surge Chamber	306416	Oxidizer	Water	750
Lube Valve Actuation	304621	Fuel	Water	750
Lube Drain Line	552095	Lube	--	--
Fuel Volute to Bleed Valve	554686	Fuel	Water	750
Bleed Valve to Bracket	554687	Fuel	Water	750
Flex Line	NA5-26333	Fuel	Water	750
Flex Line to Lube Valve	554688	Fuel	Water	750
Flex Line	NA5-26333	Helium	Gaseous Nitrogen	40
Flex Line to Lube Valve	552078	Helium	Gaseous Nitrogen	40
Lube Tank Pressurization	552063	Helium	Gaseous Nitrogen	40
Lube Supply	NA5-26340	Lube	Water	40

*A - Accelerometer
S - Strain Gage

TABLE B-2

BOOSTER CRITICAL ENGINE LINES

edia	Test Media	Pressure, psig	Tube OD and Material	Instrumentation* A	Instrumentation* S
er	Water	750	4.5-inch CRES	-	-
	Water	750	4.0-inch CRES	-	-
	Water	750	1/2-inch CRES	x	x
	Water	750	3/8-inch CRES	-	-
	Water	750	1/4-inch CRES	-	x
	Water	750	1/2-inch CRES	-	x
er	Water	750	3/4-inch CRES	x	-
	Water	750	1.0-inch CRES	x	-
er	Water	750	1- and 3/4-inch CRES	-	x
	Water	750	1/4-inch CRES	-	x
	--	--	1-1/2-inch CRES		-
	Water	750	1/4-inch CRES	-	-
	Water	750	1/4-inch CRES	-	x
	Water	750	1/4-inch CRES	-	-
	Water	750	1/4-inch CRES	-	-
	Gaseous Nitrogen	40	1/4-inch CRES	-	-
	Gaseous Nitrogen	40	1/4-inch CRES	-	-
	Gaseous Nitrogen	40	1/4-inch CRES	-	x
	Water	40	5/8-inch CRES	-	-

BOOSTER LEAK CHECK AND PRESSURIZING PROCEDURE

LEAK CHECK BY SYSTEMS

1. LUBE SYSTEM

1.1 Connect supply line to connect point No. 6 (Table B-1 an Fig.B-5).

1.1.2 All the 451112 bolts (REF 11 total) to allow for venting of the system.

NOTE: Each bolt should be loosened and retorqued separately before proceeding to the next bolt.

1.1.3 Buildup pressure to working value given in Table B-1. Ob serve system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting, and repeat step above.

1.1.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

1.2 Connect a pneumatic supply line to connect point No. 7 (Table B-1, and Fig. B-5).

1.2.1 Disconnect the lube valve actuation line from the tube valve and connect a pneumatic line to the actuation port.

1.2.2 Connect a water supply line to the lube tank through the aft quick disconnect assembly.

1.2.3 Disconnect drain line from valve and install flexible drain line.

1.2.4 Fill tank with water until steady stream of water is noted coming from drain line.

1.2.5 Remove water supply line.

1.2.6 Pressurize the lube valve actuation port to 155 psig. This will close the drain port and open the lube oil supply port and pneumatic supply port.

1.2.7 Pressurize the pneumatic supply point (connect point No. 9) to 40 psig.

1.2.8 Crack the lube oil supply line B nut at the pump inlet. Retorque after venting is complete. Leak check remainder of lube system.

1.2.9 Depressurize the lube valve actuation port.

1.2.10 Depressurize the pneumatic supply line.

1.2.11 Remove the pneumatic line from the lube valve actuation port and reconnect the lube valve actuation line.

NOTE: Do not drain the water from the lube tank assembly.

2. OXIDIZER SYSTEM

2.1 Connect supply line to connect point No. 4 (Table B-1 and Fig. B-4).

2.1.1 Slowly build up pressure to working value given in Table B-1. Observe system for leakage.

NOTE: This system will remain unvented. If leakage should occur, depressurize system, retorque fitting, and repeat step above.

2.1.2 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

2.2 Connect supply line to connect point No. 5 (Table B-1 and Fig. B-3).

2.2.1 Supply 10-psig water pressure to system.

2.2.2 Crack the AN plug at the following location to allow for venting of the system:

2.2.2.1 Oxidizer surge chamber

NOTE: Retorque after venting is complete.

2.2.3 Build up pressure to working value given in Table B-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting and repeat step above.

2.2.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

3. FUEL SYSTEM

3.1 Connect supply line to connect point No. 1 (Table B-1 and Fig. B-2) and a drain line to connect point No. 3a.

3.1.1 Supply 10-psig water pressure to system.

3.1.2 Crack the B nuts in following locations to allow for venting of the system:

3.1.2.1 Igniter fuel line at thrust chamber
3.1.2.2 Main Fuel valve actuation
3.1.2.3 Lube valve actuation port

NOTE: Each B nut should be loosened and retorqued separately before proceeding to the next B nut.

3.1.3 Use quick disconnect adapter vent system near fuel discharge flange.

3.1.4 Build up pressure to working value given in Table B-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting, and repeat step above.

3.1.5 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

3.2 Connect supply line to connect point No. 2 (Table B-1 and Fig. B-3).

3.2.1 Supply 10-psig water pressure to system.

3.2.2 Loosen bolt at the following location to allow for venting of the system:

3.2.2.1 Fuel bootstrap line adapter to gas generator control valve

NOTE: Retorque after venting is complete.

3.2.3 Buildup pressure to working value given in Table B-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting and repeat step above.

3.2.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

3.3 Connect supply line to connect point No. 3 (Table B-1 and Fig. B-4).

3.3.1 Supply 10-psig water pressure to system.

3.3.2 Crack the B-nut at the following location to allow for venting of the system:

3.3.2.1 Fuel volute bleed line at lube valve

NOTE: Retorque after venting is complete.

3.3.3 Build up pressure to working value given in Table B-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting and repeat step above.

3.3.4 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

4. PNEUMATIC SYSTEM

4.1 Connect pneumatic supply line to connect point No. 6 (Table B-1 and Fig. B-5).

4.1.1 Slowly pressurize system to working value given in Table B-1. Observe system for leakage.

NOTE: If leakage should occur, depressurize system, retorque fitting, and repeat step above.

4.1.2 Depressurize system; pressure supply line may be disconnected and capped at the pressure source.

GENERAL NOTE: All care should be taken to prevent the liquid fluid systems, once primed and leak checked, from being drained, and thus allowing air entrapment in the lines.

PRESSURIZING PROCEDURE

1.1 Connect electrical (24 volts and 1/2 ampere, maximum) to connect point No. 9.

1.1.1 Energize solenoid.

CAUTION NOTE: Solenoid must remain energized during entire test whenever pressure is up at connect point No. 4.

NOTE: As an added safety feature a pneumatic line may be connected to the pneumatic override on the hydraulic package. Pressure for this operation should be 750 psig.

1.2 Connect remaining supply lines to the connect points shown in Table B-4 and Fig. B-2 through B-6.

1.3 Slowly build up pressures to those shown in Table B-1 and in the sequence shown below:

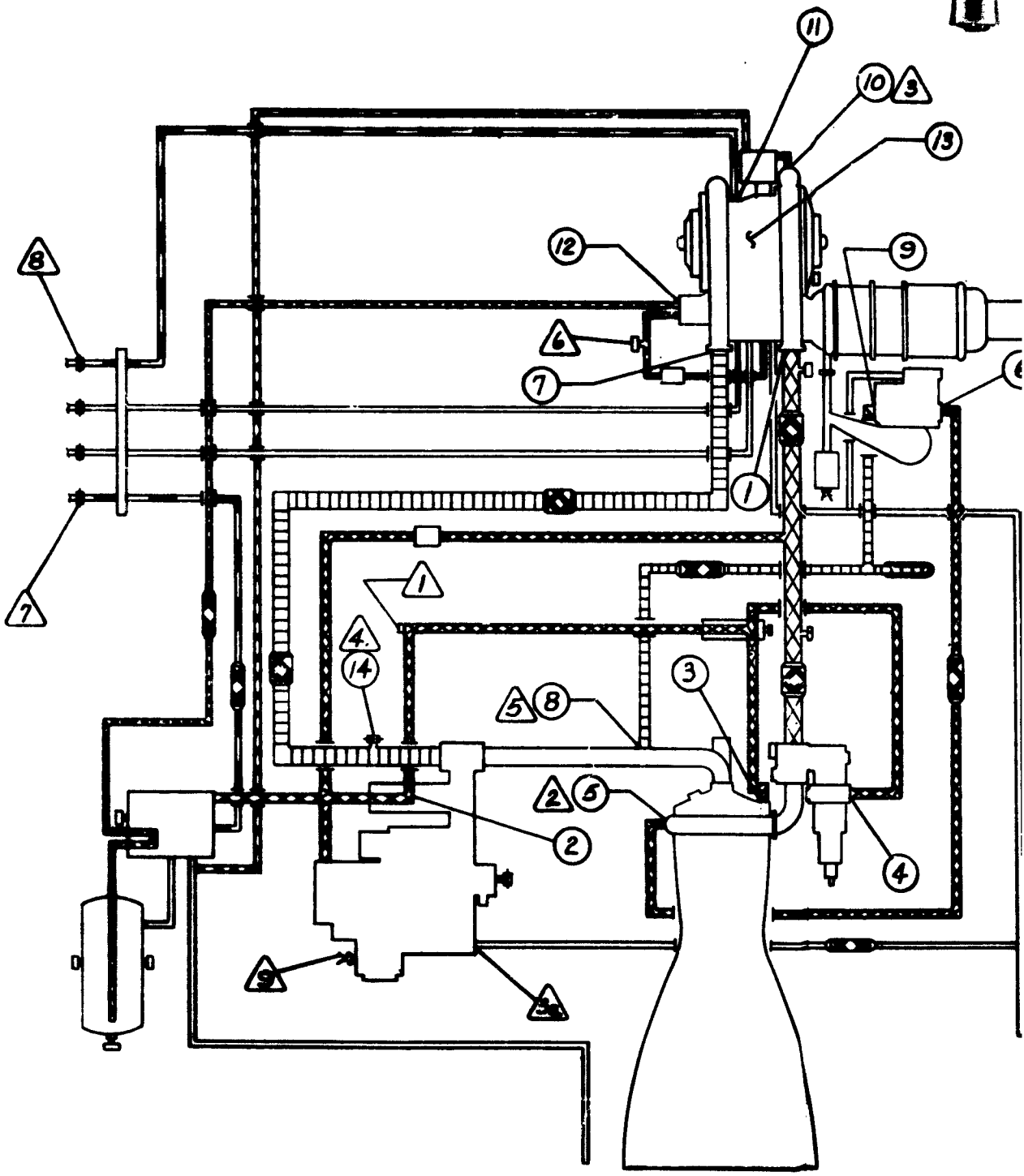
1.3.1 Fuel system

1.3.2 Oxidizer system

1.3.3 Lube system

1.3.4 Pneumatic system

NOTE: All pressures should be monitored. At no time should a B nut be retorqued while pressure is up.



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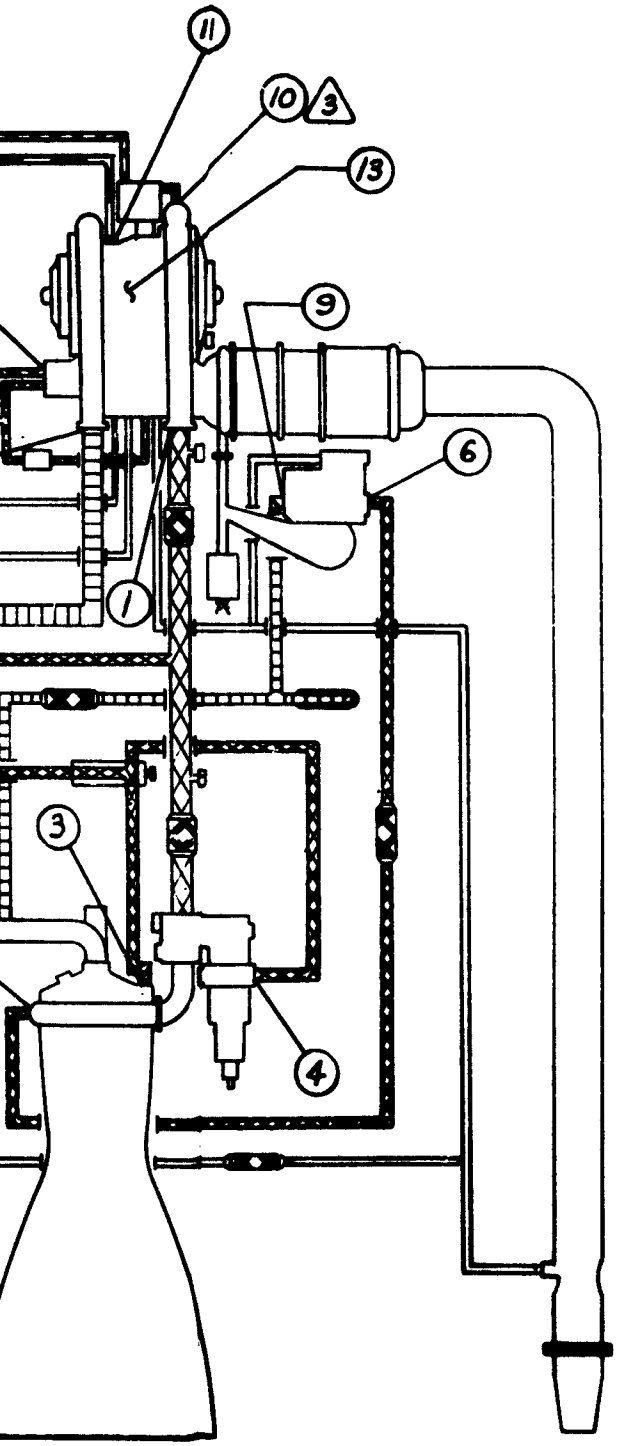

CODE:

- LUBE LINES
- PNEUMATIC LINES
- OXIDIZER LINES
- FUEL LINES
- UNPRESSURIZED LINES
- ○ ENGINE MODIFICATION REFERENCE TABLE B-3
- △ CONNECT POINT REFERENCE TABLE B-1

Figure B-7. MA-3 Booster Engine Schematic

TABLE B-3

BOOSTER ENGINE MODIFICATIONS

Item	Name	System	Installation	Modification and Purpose
1	Plate	Fuel	Fuel pump discharge	Plate added; contain system pressure and prevent overpressurization of turbopump
2	Igniter fuel valve	Fuel	Main oxidizer valve assembly	Removal of poppet; allow flow-through conditions
3	Fitting	Fuel	Igniter fuel at thrust chamber	Plugged union added; contain system pressure
4	Fitting	Fuel	Main fuel valve assembly	Plugged elbow added; contain system pressure prevent actuation of valve
5	Adapter	Fuel	Fuel bootstrap at manifold	Adapter added; supply pressure to fuel bootstrap line
6	Fitting	Fuel	Fuel bootstrap at gas generator assembly	Blank orifice or plate added; contain system pressure
7	Plate	Oxidizer	Oxidizer pump discharge	Plate added; contain system pressure and prevent over-pressurization of turbopump
8	Adapter	Oxidizer	Oxidizer bootstrap at elbow	Adapter added; pressurize oxidizer bootstrap line
9	Plate	Oxidizer	Surge chamber at gas generator valve	Plate added; contain system pressure

TABLE B-3
(Continued)

Item	Name	System	Installation	Modification and Purpose
10	Fitting	Fuel	Fuel volute	Bulkhead tee with one end plugged added; supply pressure to bleed system
11	Fitting	Pneumatic	Oxidizer cavity purge	Blank restrictor added; contain system pressure
12	Fitting	Lube	Lube pump inlet	Reworked 454063 bulkhead elbow added
13	Jet assemblies	Lube	Turbopump	All lube oil jets welded closed to maintain system pressure
14	Fitting	Oxidizer	Oxidizer chill-down boss	Pressure plate added; supply pressure to oxidizer duct